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ABSTRACT

The Florida State model of computer-managed instruction (CMI) differs from other such models in that it assumes a student will achieve his maximum performance level by interacting directly with the computer in order to evaluate his learning experience. In this system the computer plays the role of real-time diagnostician and prescriber for the student and serves as a master record-keeper for the entire student population. To test this model of CMI, systems concepts were used in developing a programed course to teach graduate education students the techniques of programed instruction. In a field trial of the course, four instructional presentations were used: students followed a fixed sequence of tasks and had a graduate student evaluate their progress, students selected their own sequence of tasks and had a graduate student evaluate their progress, students followed a fixed sequence and evaluated their progress with the aid of a computer, and students selected their own sequence and evaluated their progress with the aid of a computer. No significant differences were found among the experimental treatment groups. Student performance on the cognitive portion of the course was excellent, and it was estimated that the cost of conducting the course via CMI was one-half to one-third the cost of conventional graduate instruction. (Author/JY)

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TECH MEMO

SYSTEMS CONCEPTS AND COMPUTER-MANAGED INSTRUCTION:

AN IMPLEMENTATION AND VALIDATION STUDY

Walter Dick and Paul Gallagher

Tech Memo. No. 32
April 15, 1971

Project NR 154-280
Sponsored by
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Duncan N. Hansen
Director
CAI Center

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In the evaluation study, several experimental treatment variations were investigated. One variable was the comparison of the performance of students who selected their own instructional sequence as compared to those who were required to follow a set sequence. The other comparison

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was between the performance of students who interacted with graduate assistants as they evaluated their progress in the development of a programmed instruction sequence. The other students interacted directly with the computer in order to assess their progress.

The analysis of the results indicated no significant differences among the experimental treatment groups. An accurate analysis of the time and effort required on the project indicated that the development costs were approximately $9,000, while the implementation cost for 59 students was approximately $3,500.

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In the evaluation study, several experimental treatment variations were investigated. One variable was the comparison of the performance of students who selected their own instructional sequence as compared to those who were required to follow a set sequence. The other comparison was between the performance of students who interacted with graduate assistants as they evaluated their progress in the development of a programmed instruction sequence. The other students interacted directly with the computer in order to assess their progress.

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SYSTEMS CONCEPTS AND COMPUTER-MANAGED INSTRUCTION: AN IMPLEMENTATION AND VALIDATION STUDY[1]

Walter Dick
Paul Gallagher[2]

This report describes the utilization of systems concepts in the development of a course which was presented to students via computer-managed instruction. The instructional model employed in this study was derived from the results of numerous research studies conducted at the CAI Center at Florida State University (Hansen, Dick, Lippert, 1969), and elsewhere, which seem to indicate that while tutorial CAI is an effective instructional strategy, it is unlikely that, in the short run, it is going to make a significant impact on education because of the cost associated with one student utilizing a terminal for relatively long periods of time during each instructional session. Therefore, other types of computer strategies, such as simulation and on-line problem solving have been explored by Florida State and others. Flanagan's (1968) Project Plan is most representative of a form of computer utilization in the instructional process which has been labeled computer-managed instruction (CMI). The four or five projects now reported in the literature which go by the term CMI, generally, but not always, involve individualized instruction in a classroom and the use of frequent paper and pencil evaluation instruments. The computer is used to analyze tests and provide feedback to the teachers in order that they may assist students as they progress through a course.

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[1]This study was conducted in the CAI Center at Florida State University and was supported in part by an Office of Naval Research contract, number N00014-68-A-0494. The authors wish to acknowledge the contribution of Dr. Nancy Hagerty to the initial course development and implementation efforts.

[2]Now at Florida International University.

The Florida State model of CMI differs significantly from that used by other researchers. It assumes that a student will achieve his maximum performance level by interacting directly with the computer in order to evaluate his learning experience, i.e., the computer should play the role of real-time diagnostician and prescriber for the student, as well as a master record-keeper for the entire student population in a particular instructional program.

In order to test this model of CMI, systems concepts were utilized to develop a course, Techniques of Programmed Instruction, a graduate-level course in the College of Education at Florida State. The course basically teaches students to develop programmed instruction materials through the use of a systems approach model. It was this model, which is taught in the course, that was utilized for structuring the development of the CMI course.

The model (Dick, 1969) is based primarily on earlier work by Glaser (1963), and Stolurow and Davis (1965). Figure 1 shows that this "systems approach" is in essence a model which indicates the sequential processes which one would follow in order to develop instructional materials. The various components in the model are based upon concepts developed by various researchers; e.g., task analysis, Gagne (1970); behavioral objectives, Mager (1962); formative evaluation, Cronbach (1963); and media selection, Briggs, et al (1967).

The purpose of this report is to describe how the model was used to develop materials which were implemented via computer-managed instruction in a graduate course, and to indicate the outcomes of that course in terms of costs for development and implementation, as well as student attitudes and performance.

INSERT FIGURE 1 ABOUT HERE

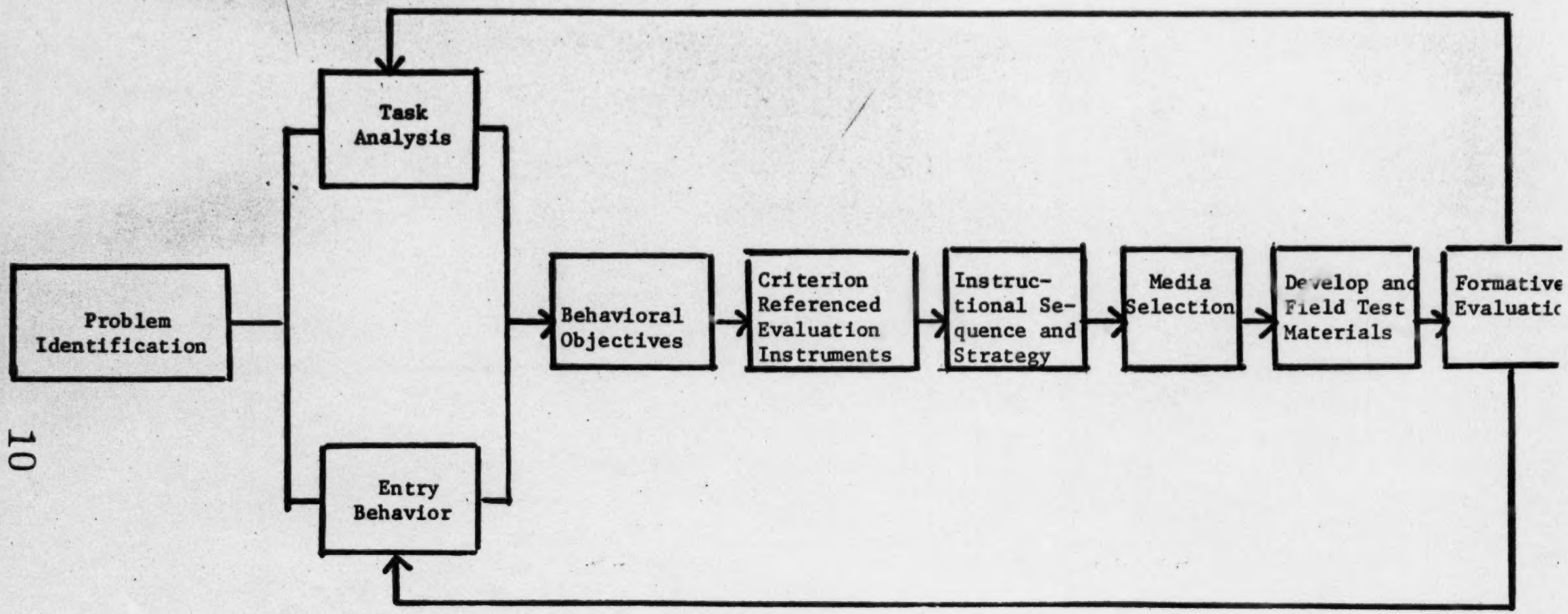

Figure 1. Systems Approach Model Used for the Development of CMI Course Materials

Described below is the step-by-step development of the course as the development team worked systematically through the steps suggested by the systems approach model.

PROBLEM IDENTIFICATION

The course of instruction used in this study was Educational Research 537, Techniques of Programmed Instruction. Until this investigation, the course had been taught via conventional lecture techniques. The major objective of the course is to provide the student with a working knowledge of both the cognitive and productive aspects of the use of the systems approach in the design of instructional materials, particularly programmed instruction. The cognitive aspects can be thought of in terms of specific content that is to be mastered. The productive aspects of the course can best be considered as being similiar to a set of skills required to conduct a course project.

The decision to implement the Techniques of Programmed Instruction course in a CMI mode was based on an analysis which revealed the following: 1) the course was one which was taught on a regular twice-a-year basis with an enrollment of 40 to 60 students per term, 2) the student population varied in both background and experience thus creating a large variance in entry behavior, 3) the course content was relatively stable, and 4) there was sufficient experienced manpower available to design and implement such a course. Operating on the above set of met criteria, it was decided that the chosen course was suitable for adaption to a Computer-Managed Instruction mode.

TASK ANALYSIS

In adapting Techniques of Programmed Instruction for CMI, the initial step was to clearly identify the terminal goal or objective for the course. Figure 2 indicates that this was identified as being, "(The student shall be able to) Produce a document describing Systems Approach development, and standardized evaluation of a programmed instruction text." Subtasks were identified through the use of

Gagne's (1970) hierarchial analysis techniques. As a result of this analysis, 19 subtasks were identified as comprising the course. The subtasks represent the necessary skills a student must acquire in order to design, implement, and evaluate a programmed unit of instruction. These tasks were, in turn, categorized as cognitive and/or productive as follows:

A. Cognitive Task - The student has to demonstrate competency by achieving at least a level of eighty per cent correct responses on a criterion-referenced objective test which is administered at the CMI terminal. For example, the student is required to correctly answer at least four of five questions which are randomly selected by the computer which pertain to types of programmed instruction frame

B. Productive Task - The student has to demonstrate competency by constructing a product which meets certain pre-set criteria. For example, the student is required to properly respond to a set of questions asked by the computer in order to demonstrate that he has developed a plausible formative evaluation plan.

C. Cognitive and Productive Task - On this type of task, the student has to complete activities related to both A and B as described above. For example, the student has to demonstrate competency in identifying various characteristics of "entering behavior". In addition, he is required to properly respond to a set of questions in order to demonstrate that he has identified the major entering behavior characteristics of the students who will serve as the target population for his proposed programmed instruction unit.

'INSERT FIGURE 2 ABOUT HERE

ENTRY BEHAVIOR

Since all those who enroll for this course must be graduate students, certain

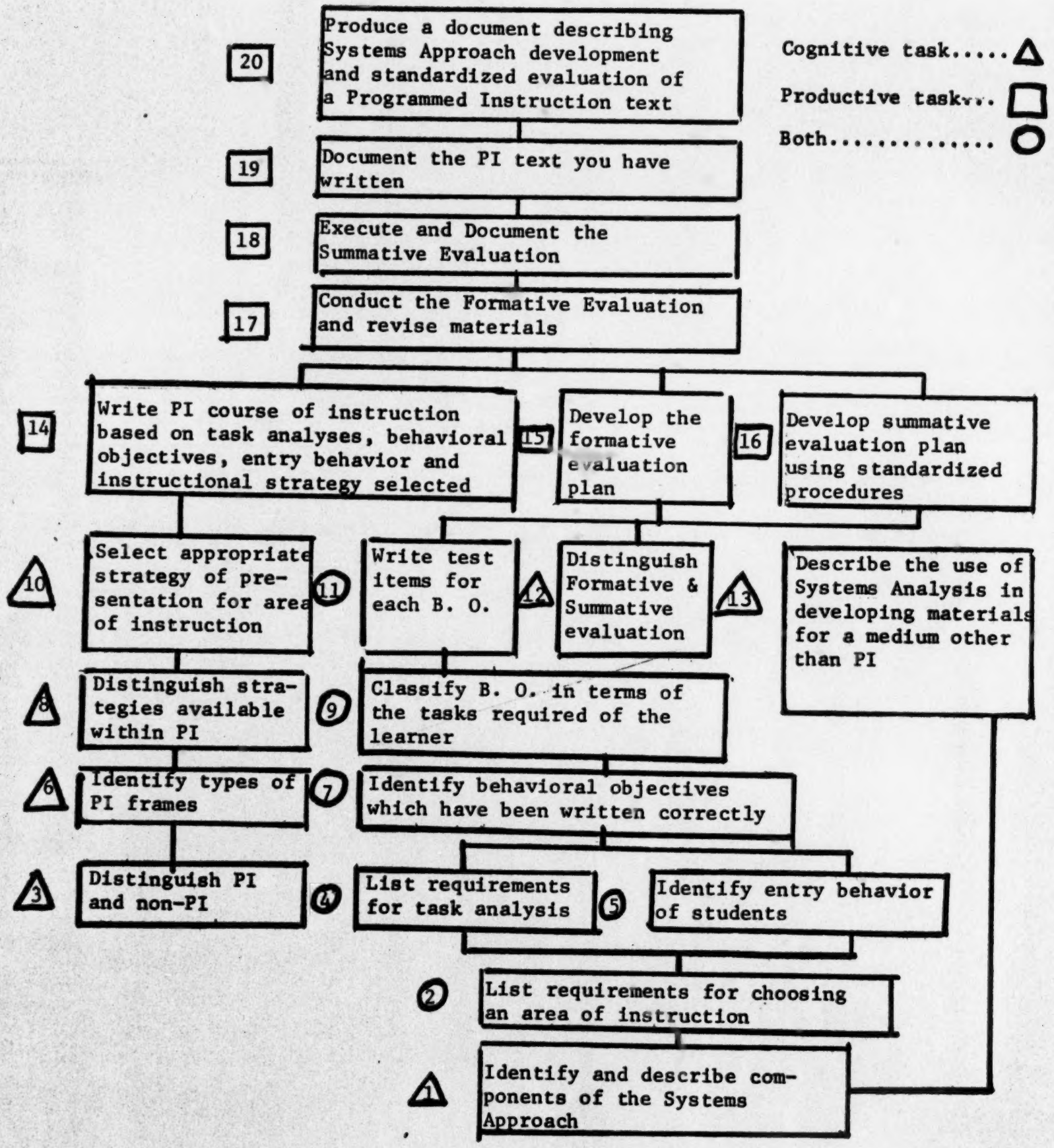
Produce a document describing Systems Approach development and standardized evaluation of a Programmed Instruction text
20
Document the PI text you have written
19
Execute and Document the Summative Evaluation
18
Conduct the Formative Evaluation and revise materials
17
Write PI course of instruction based on task analyses, behavioral objectives, entry behavior and instructional strategy selected
14
Develop the formative evaluation plan
15
Develop summative evaluation plan using standardized procedures
16
Select appropriate strategy of presentation for area of instruction
10
Write test items for each B. O.
11
Distinguish Formative & Summative evaluation
12
Describe the use of Systems Analysis in developing materials for a medium other than PI
13
Distinguish strategies available within PI
8
Classify B. O. in terms of the tasks required of the learner
9
Identify types of PI frames
6
Identify behavioral objectives which have been written correctly
7
Distinguish PI and non-PI
3
List requirements for task analysis
4
Identify entry behavior of students
5
List requirements for choosing an area of instruction
2
Identify and describe components of the Systems Approach
1
Cognitive task.....
Productive task...
Both.....

Figure 2 Task Analysis of the Course Techniques of Programmed Instruction

basic entry skills, knowledge, and abilities are implied by their status. It was assumed only that they would be capable of describing in a formal report the activities they carried out as they developed their programmed instruction unit.

BEHAVIORAL OBJECTIVES

The next step in the development of the course was to establish specific behavioral objectives for each of the tasks delineated in the hierarchal analysis. A minimum of one and a maximum of three behavioral objectives were constructed for each of the cognitive tasks. For each productive task, one behavioral objective was constructed.

All of the objectives defined what the student had to be able to do, under what conditions, and to what level of proficiency. For example, Task 7, which deals with the topic of behavioral objectives, has a cognitive objective in which the student has to identify the major components of a behavioral objective and another cognitive objective in which the student has to demonstrate that he can identify objectives which are poorly written. The objective for the productive aspect of this task requires the student to write behavioral objectives, according to Mager's (1962) guidelines, for each of the tasks which will be included in his programmed instruction text.

CRITERION REFERENCED EVALUATION INSTRUMENTS

After the behavioral objectives were written for each task, fifteen criterion-referenced test items were constructed for each of the cognitive objectives. From this pool of fifteen items five would be randomly selected by the computer and presented to the student at the terminal to test his achievement of each objective.

The test items were in a multiple-choice format. Since time did not permit pretesting them for validity and reliability, the items were presented to three content experts for their professional judgment as to whether the items were, in fact, measuring achievement of the intended objectives. After revisions by these

judges, the items were coded in Coursewriter II and implemented on the IBM 1500 CAI System.

Criterion-referenced pre- and post-tests were also constructed at this stage in the development process. The pre-test was a sixteen item short-answer criterion-referenced test. It was administered to ascertain the entry knowledge of course content by the students who enroll for the course. The post-test was an alternate form of the pre-test. It was administered to measure the student's overall achievement of the cognitive behavioral objectives.

For each productive objective, a set of questions which matched a specific criteria were constructed for administration via computer. The appropriateness of the student's responses to these questions determined whether or not he successfully completed the productive component of the task. For example, one of the necessary criteria for Task 7 was that the student write at least one behavioral objective for each task of his task analysis. Therefore, as one of the criteria for "passing" this objective, the student has to certify (to the computer) that he does, in fact, have at least one objective for each task.

The final product evaluation instrument was a rating checklist used to assess the student's documentation of the design, implementation and evaluation of his programmed instruction text.

INSTRUCTIONAL SEQUENCE AND STRATEGY

When the present course had been taught via the traditional lecture method, the steps in the Systems Approach (Figure 1) were presented in sequence from left to right. The task analysis developed for the CMI implementation includes one or more separate tasks for each step in the model. This analysis, based on Gagne's hierarchial model (1970), presumes that each lower level task must be achieved before the next higher level task can be learned. Therefore, according to this procedure, in order for a student to accomplish the final task of "Producing a

document describing the Systems Approach development and standardized evaluation of a programmed text," he must successfully progress through Task 1, then 2, etc., to Task 20.

In order to investigate the criticalness of the sequence in which students study the tasks, two experimental conditions were investigated during the field trial of the course. One-half of the students studied the tasks in the fixed sequence as shown in Figure 2. The rest of the students were permitted to study the tasks in any sequence that seemed appropriate.

An additional strategy question was investigated during the field trial. Of critical concern in terms of the overall effectiveness of the course was the viability of using a student-computer dialogue as the procedure for reviewing the students' progress in the development of their own programmed instruction unit. In order to evaluate this procedure, one-half of the students in the fixed sequence group and one-half in the self-selected sequence group were assigned to the "computer evaluation" strategy, while the remaining students had their task products checked by graduate students who asked essentially the same questions as those which were programmed into the computer. Thus, there were four experimental groups:

1. Sequence Assigned/Instructor Evaluated Products - This group of students proceeded through the twenty tasks in an assigned sequence. All students started with Task 1 and worked consecutively through Task 20. The students' products, e.g., behavioral objectives, test items, etc., were evaluated as they were completed by one of the course assistants.

2. Sequence Assigned/Computer Evaluated Products - This group of students proceeded through the twenty tasks in the assigned sequence (1 through 20 consecutively); however, the products which they produced were evaluated by the students themselves via an interactive dialogue with the computer. Upon completion of the interaction, the students passed or failed themselves on the particular product.

3. Self Sequence/Instructor Evaluated Products - This group of students had

the freedom to proceed through the 20 tasks in a self-sequencing mode. The students' products were evaluated by one of the course assistants.

4. Self Sequence/Computer Evaluated Products - These students also had complete autonomy in the sequencing of the 20 tasks. Their products were evaluated by a student-computer interaction, with the students passing or failing themselves.

MEDIA SELECTION

The next step in adapting the course using the Systems Approach was to consider the media which would be utilized by the students in order to gain the information necessary to accomplish the behavioral objectives for the course. The major media utilized were published texts and journal articles. Films, slides, and tapes were also available; however, their use was very limited. In addition to these resources, the course professor and his graduate assistants also served as resource personnel.

All references which were used were selected because they met the information requirements of the specific behavioral objectives. These references included books, articles, journals, papers, pamphlets, and specifically constructed summaries. The specific pages from these sources were referenced and included in a Study Guide. Other important resources were the programmed texts and reports prepared by students who had previously taken the course.

IMPLEMENTATION OF THE GRADUATE COURSE

At the initial meeting of the course, the students were given the Student Guide. After a general explanation of the course, the students were given a detailed description of the procedures which would be used under CMI. They were told that, after studying for a task, they should schedule a terminal at the CAI Center in order to take a quiz on the specific behavioral objectives for that task. Each of the quizzes consisted of five items randomly selected by the computer from the pool of fifteen which were written for each of the objectives in the task.

The criterion for a passing performance was a correct response on at least four of the five items. For the productive objectives, the student was required to respond to a series of questions concerning his product. Depending upon the group to which the student was assigned, these questions were asked either by the computer or a graduate assistant. Following the evaluation, the student was required to either restudy the instructional materials and be retested with another random set of test items, or to choose the next task he wanted to work on.

No more classes were scheduled until the final meeting of the course. The students proceeded through the course in an individualized, self-paced manner; they simply reported to the CAI Center when they were ready to be evaluated on a task which they had completed.

Upon completion of the first thirteen tasks, the students were given a mid-term examination on the cognitive objectives for those tasks. This examination could be taken at any time during the first seven weeks of the course. A student's Documented Report on the development and evaluation of his PI sequence could be handed in at any time up to and including the final class session when the entire class met as a group.

FORMATIVE EVALUATION

The formative evaluation of the course involved the collection of various types of data including student performance, student attitudes and developmental and implementation costs.

STUDENT PERFORMANCE - Comparisons among the instructional treatment groups were made in four separate two-way analyses of variance in which the following dependent variables were used: (1) midterm examination on the cognitive information in the course, (2) the final evaluation score on the documented PI text, (3) total time spent at the CMI terminal, and (4) the time (in days) to complete the cognitive portion of the course (Tasks 1-13). For each of the 2 x 2 analyses of variance,

sequence of tasks (assigned vs. selected) and method of evaluation (computer vs. instructor) were the independent variables.

The means and standard deviations for the midterm examination scores are presented in Table 1. It may be noted that there is very little difference in mean performance among the four groups, and the F was not significant. The absence of statistically significant effects indicates that the scores on the midterm examination were not influenced by the type of sequencing or evaluation. It should be noted that the maximum score possible on the examination was 103, and that the mean performance by all groups was much higher than the desired 80% criterion level.

TABLE 1 ABOUT HERE

Table 2 presents the means and standard deviations of the four instructional treatment groups on the final evaluation of their documentation of their PI text. Analysis of variance indicated there were no significant differences among the groups on their documentation scores.

TABLE 2 ABOUT HERE

With regard to total time spent at the CMI terminal, Table 3 presents the means and standard deviations. The results of the analysis of variance presented indicate that there were no significant differences among the groups. It should be noted that the average student spent approximately four and one-half hours at the terminal during the ten week quarter, rather than 30 hours in a classroom.

TABLE 3 ABOUT HERE

The means and standard deviations for total number of days, including spent on the weekends, cognitive portion of the course (Tasks 1-13) are presented in Table 4. The

TABLE 1 -- Means and standard deviations of four instructional treatments on the midterm examination. (Maximum score 103)

Instructional Treatment	Mean Score	Standard Deviation
Self Sequenced Computer Evaluated	95.80	4.46
Self Sequenced Instructor Evaluated	95.27	5.53
Sequenced Assigned Computer Evaluated	92.14	9.15
Sequenced Assigned Instructor Evaluated	94.73	4.33

TABLE 2 -- Means and standard deviations of four instructional treatments on their documentation of their PI test. (Maximum score 74).

Instructional Treatment	Mean Score	Standard Deviation
Self Sequenced Computer Evaluated	50.53	9.75
Self Sequenced Instructor Evaluated	51.53	7.00
Sequence Assigned Computer Evaluated	46.06	9.93
Sequence Assigned Instructor Evaluated	48.93	8.04

TABLE 3 -- Means and standard deviations of four instructional treatments for total time spent at the terminal (system time).

Instructional Treatment	Mean	Standard Deviation
Sequence Selected Computer Evaluated	260.20	54.11
Sequence Selected Instructor Evaluated	251.53	44.32
Sequence Assigned Computer Evaluated	284.28	46.96
Sequence Assigned Instructor Evaluated	262.53	39.79

TABLE 4 -- Means and standard deviations of four instructional treatments for time (days) to complete tasks 1-13.

Instructional Treatment	Mean (Days)	Standard Deviation
Self Sequence Computer Evaluated	42.80	4.77
Self Sequence Instructor Evaluated	41.87	5.71
Sequence Assigned Computer Evaluated	43.20	2.62
Sequence Assigned Instructor Evaluated	42.64	4.85

results of the analysis of variance indicate no significant differences among the groups.

TABLE 4 ABOUT HERE

STUDENT ATTITUDES - In order to determine the attitudes of the participating students, specific attitude and information questionnaires were administered as part of the formative evaluation. Data generated by these questionnaires was intended to supply information which would be helpful in course revision. Student responses to a sample of these questions are listed below.

When asked if they would enroll for another CMI course, 55% responded "Gladly", 37% responded "Possibly", and only 4% responded "Reluctantly" or "Never." This data gives an indication of the overall positiveness of the students toward the course.

Students were then asked questions as to the relevancy and adequacy of the questions asked either by computer or by the graduate assistants about their products as they progressed through the course. Sixty-seven per cent of the students indicated that the questions were relevant; 14% said that they were extremely relevant, and 15% indicated that some were relevant. Likewise, 68% felt that most of the questions were adequate; 17% felt that some were adequate, and 9% said that they were extremely adequate.

A modified form of Brown's CAI scale was also administered to measure specific attitudes toward CMI. Out of a possible 200 points, the range was from 95 to 172 for the class. The overall mean was 142.02 with a standard deviation of 14.99 indicating that the class did, indeed, purport positive attitudes toward the course.

In summary, the general feelings expressed by the majority of the students were that the course was well organized. Detailed data on specific task-by-task performance was collected to assist in the revision process, but will not be reported here.

COST FACTORS - The costs incurred for the development and operation of the CMI course for one quarter are presented in Table 5. The total developmental cost was $9,297.40. This cost includes the identification and selection of the course materials, the logic for the computer coding and entry of materials, and a minimum of secretarial assistance.

The implementation and evaluation costs totaled $3,568.86. This cost includes Resource Center, Instructional, and Computer costs. In order that students would not have to purchase all of the books and articles which were required, a Resource Center was established for the course. The cost of stocking this Center with books and reproduced copies of various articles was $344.40.

The instructional costs included professorial and graduate assistant time, plus the publication of the student Study Guide. A total of approximately 480 manhours of assistance were made available to the students in the course. This included 40 hours spent by the course professor and 440 spent by the two graduate assistants. Costs for the graduate assistants' time, based on a $4.00 hourly rate, came to $1,760.00. In order to obtain an actual cost of faculty time, the professor kept an accurate record of the time he spent interacting with students. This totaled only 3 hours and 21 minutes. In addition, the instructor spent approximately 30 hours evaluating the final products of the students. The total instructor time spent on the course was computed to be one-tenth time at a cost of $450.00. These costs in addition to $150.00 for the publication of the Study Guide sum to a total implementation cost of $2,360.00.

The total computer cost was $864.46. This figure was based on the average of 4.4 hours of terminal time for the 59 students in the course. The FSU CAI Center rate is $3.33 per student hour. Thus, the total implementation cost was $3,568.86.

A cost comparison of the CMI method with the traditional lecture method

indicates that the CMI approach is less expensive to operate than conventional instruction at Florida State. The cost of teaching 59 graduate students a three credit hour course by traditional methodology is equivalent to 177 graduate quarter hours, or 1.4 professorial positions. Using an average faculty salary of $4,500.00 per quarter, this is a cost of $6,300.00. The course has recently been approved as a 5 credit hour course, and, therefore, the 59 students would now produce 295 quarter hours or the equivalent of 2.3 professors. At the $4,500.00 per quarter average rate, the cost of presenting this course via traditional lecture mode would be $10,350.00. Conservatively, the cost of conducting the course via CMI is one-half to one-third the cost of conventional graduate instruction at Florida State.

TABLE 5 ABOUT HERE

SUMMARY AND IMPLICATIONS

The purpose of this paper was to describe how a Systems Approach technique could be used in the design, implementation and evaluation of a successful Computer-Managed Instruction course. By systematically following each step, while utilizing continuous feedback for adaptations, a graduate-level course was adapted to an individualized CMI course. The outcomes of the implementation of the course indicated excellent student performance on the cognitive portion of the course. The data suggested that revision was needed in materials used to teach the students how to document the development of their PI text.

The statistical analysis of the performance of the students indicated that self-selection of the sequence in which tasks are taken produces results which are not different from those obtained with a fixed task sequence. More important was the lack of difference in student performance between those who reviewed the various components of their PI text with the graduate assistants and those

TABLE 5

DEVELOPMENTAL AND OPERATIONAL EXPENDITURES FOR CMI COURSE

Category	Expenditures
I. Developmental Costs	
Development of CMI course Materials and Logic	$1,400.00
CAI Coding and Entering of Materials on the Computer	7,817.40
Secretarial Staff	80.00
Total Developmental Costs	$9,297.40
II. Implementation	
A. Resource Center Costs	
Books	$ 264.40
Reproducing Materials	80.00
Subtotal	$ 344.40
B. Instruction Costs	
Publication of Handout	$ 150.00
Student Assistants	1,760.00
Professor (1/10 time)	450.00
Subtotal	$2,360.00
C Computer Costs	$ 864.46
Total Operational Costs	$3,568.86
PROJECT COSTS	$12,866.26

who evaluated their own products via a computer-directed dialogue.

This project has also demonstrated the effective, low-cost use of a CAI system. Based on the data from this study it is apparent that numerous CMI courses could be implemented at the same cost of a single CAI course. Comparisons of CMI costs with those of traditional instruction are also quite favorable.

REFERENCES

Briggs, L.J., Campeau, P.L., Gagne, R.M., & May, M.A. Instructional media: A procedure for the design of multi-media instruction, a critical review of research, and suggestions for future research. Palo Alto, Calif.: American Institutes for Research, 1967.

Cronbach, L.J. Evaluation for course improvement. Teachers College Record, 1963, 64, 672-683.

Dick, W. Some directions for the College of Education in the '70's. In Hansen, D., Dick, W. & Lippert, H.T. Annual Progress report, January 1, 1968 through December 31, 1968. Tallahassee, Florida: Florida State University, 1969. pp. 107-117.

Flanagan, J.C. Project PLAN. In Aerospace Education Foundation Technology and innovation in education. New York: Praeger, 1968. pp. 113-120.

Gagne, R. M. The conditions of learning (2nd Ed.). New York: Holt, Rinehart and Winston, 1970.

Glaser, R. Toward a behavioral science base for instructional design. In R. Glaser (Ed.), Teaching machines and programmed learning, II. Washington, D.C.: National Education Association, 1965. pp. 771-809.

Hansen, D.H., Dick, W., & Lippert, H.T. Annual progress report, January 1, 1968 through December 31, 1968. Tallahassee, Florida: Florida State University, 1969.

Mager, R.F. Preparing instructional objectives. Palo Alto, Calif.: Fearen Publishers, 1962.

Stolurow, L.M., and Davis, D. Teaching machines and computer-based systems. In R. Glaser (Ed.), Teaching machines and programmed learning, II. Washington, D.C.: National Education Association, 1965. pp. 162-212.